NEWS IMPPLIED VOLATILITY INDEXES

Dumitru-Nicuşor CĂRĂUŞU
Faculty of Economics and Business Administration, University Alexandru Ioan Cuza
Iași, Romania
nicusor@live.com

Abstract *The impact of new information on stock market prices has gained a lot of attention from academics and policy makers alongside the development of the modern portfolio theories. Therefore, in the recent years we noticed an ever-growing number of studies that try building news implied volatility indexes as a proxy for investors perception related to new information in the media. While some of the volatility-based news index sources are powerful instruments that can predict future stock price movement, their applicability seems to be limited while the results can be inconclusive sometimes. The main issues surrounding news-based volatility indexes rise from their inability to incorporate all types of information, or the lack of a true validation system for the information included in the analysis. Furthermore, there are some major methodological concerns regarding some types of indexes, or data source included in building the index. Overall, our results indicate despite some concerns regarding the composition of the indexes, many news-based volatility indexes can be used as powerful instruments by both investors and policy makers.*
Keywords *capital markets, economic policy uncertainty, news implied volatility, wavelet analysis,*

1. INTRODUCTION

The relationship between uncertainty and volatility of capital markets is a concern of investors due to the risks associated with unexpected changes in the prices of financial assets. Therefore, a whole series of studies have appeared in the literature aimed at quantifying the effect, which information has on the evolution of share prices and volatility in a market. Technological advances in automatic document analysis have facilitated the examination of information in the press in the form *news implied volatility indexes*. In general, information-based volatility indices from the press first analyze and group all information in the press on the economic and social situation of a state, and then verify that the information is relevant at the level of each firm.

While the role of news media on the evolution of capital markets has been a widely discussed topic in the economic literature ever since the development of modern portfolio theory, and especially since the need for diversifying assets in different countries has led to many new developments in risk management and corporate valuation. Despite, the abundant number of articles depicted in the news media most of the studies focused on the impact of news on the overall macroeconomic environment, while testing the impact of news on investor's reactions has been less discussed in the literature (Liu & Zang, 2015).

Ever since the initial studies of Niederiffer (1971), which revealed the role of new information in the media and changes in stock prices, to modern studies like Manela and

Moreira (2017) or Boudoukh *et al.*, (2019), this topic has been a focus of many academics and policy makers in emerging and developed capital markets. Furthermore, while the pioneer studies in this field focused primarily on identifying and measuring the impact of the phenomenon, modern studies tend to take a close note on not only detecting the phenomenon but rather identifying and testing methods to prevent and forecast the impact of news media on stock prices.

With the development of theoretical approaches to role, which news plays on the evolution of share prices and thanks to technological advances in the literature, a whole range of indicators aimed at quantifying the manner in which capital markets react to different types of information emerged. Thus, gradually a whole series of indices appear in the literature, which try to quantify all the information that appeared in the specialized press or other official communication channels that can influence the evolution of the prices of companies' shares. If only information concerning: *company announcements* (Niederhoffer, 1971) was used in the first studies on this topic, the information *appearing in specialized journals* was gradually incorporated (Chan, 2003; Tetlock, 2007; Tetlock *et al.*, 2008) and subsequently included the information available *from* social *media* (Bukovina, 2016), or even *all* available *sources of information* (Boudouk *et al.*, 2019; Onofrei et al., 2019).

The use of an increasing number of sources of information to build volatility indices has been made possible against the background of technological advances in the processing of big data information using sophisticated information processing algorithms, which allow the assessment of as much information as possible. In general, the processing of information on volatility indices is carried out using automated information processing algorithms based on artificial intelligence, which allows a much faster quantification of the information available without human intervention (Bukovina, 2016). Therefore, the effectiveness of capital market volatility indices is primarily based on their ability to process large volumes of data that cannot be easily processed by a simple financial analyst.

The rest of this paper is organized as follows: Section 2 provides a brief introduction behind the role of the data used in creating news-implied volatility indexes, Section 3 presents debates and controversies surrounding the indexes, and Section 4 concludes.

2. THE ROLE OF DATA SOURCES IN THE CALCULATION OF NEWS-BASED VOLATILITY INDICES

Alongside technological advances in information processing techniques, it has been possible to incorporate an increasing number of sources of information to build news-based volatility indices. Starting from simple announcements about the evolution of a company, to the inclusion of information from specialized journals or social media the efficiency of news-based volatility indices has increased considerably over the past decade. Therefore, the analysis of the effects of news-based volatility indices on developments must consider the nature of the information but also the manner in which it is processed.

Several categories of available sources of information are present in the literature but they can be grouped into four distinct categories as follows: (1) *public information about companies;* (2) *the specialized press;* (3) *social media*; (4) *all available sources of information*.

1. Public information **on companies** is a main source in determining news-based volatility indices as a primary source in determining a company's economic fundamentals. Since Niederhoffer's first studies in 1971, the role of company announcements on the evolution of financial indicators (profitability, turnover, investments, etc.) or aspects of company management have been factors influencing the evolution of the share price of listed companies. In addition, recent studies such as (Chan, 2003; Tetlock, 2007; Tetlock *et al.*, 2008; Liu and Zang, 2015) points out that company information is the benchmark in establishing the economic basis. Thus, if the impact of any type of information available is to be compared to a reference point, then the information on the financial statements is used and the announcements provided by the company are benchmarks. In this type of data source, consideration is given to: the presentation of annual financial statements, corporate governance, announcements on mergers and acquisitions, the existence of conflicting situations within the company or other companies, etc.

Studies testing the impact of these news categories offer a whole host of conflicting results, but overall there are some important elements regarding this type of information: negative news about company management or financial results allows to predict the price of companies' shares (Tetlock *et al.*, 2008); company news plays a greater role in periods of non-financial crisis depending on the nature of the activities undertaken by companies (Shi *et al.*, 2016); the trading volume of companies is not influenced by the same type of news as the volatility of companies (Shen *et al.*, 2018).

2. The specialized press is the vector of influence that allows the characterization of the general economic climate in a country, region, or at the global level. The inclusion in news-based volatility indices of information on a state's macroeconomic development, the nature and effectiveness of public policies promoted by state governments, the state of conflict or war between states are just a few of the indicators intended to quantify investors' overall perception of the economic and social environment in a state. In the case of this category of news, the focus is rather on quantifying the state of general pessimism among investors (Tetlock, 2007), the inadvertence of public policies promoted by some states (Gulen, Ion, 2015), or the presence of conflicting states at regional or global level (Manela, Moreira, 2017). In addition, it should be noted that volatility indices usually use only specialist media sources which are recognized for the objectivity of these being avoided controversial sources. As a rule, the main reference source used in the literature is the Wall Street Journal, which has a history of more than 130 years of journalistic excellence.

In the case of these categories of sources of information, the empirical results reveal not only the importance of the nature of the news circulated in the specialized press but also their impact on the evolution of volatility of some companies or capital markets. Some of the most important results in this regard reveal that: if pessimistic information prevails in the specialized press then the price of companies is reduced and the volatility of capital markets increases (Tetlock, 2007); public policy instability does not directly affect corporate volatility, however, being an important factor for investment decisions (Gulen, Ion, 2015), conflict and war states lead to increased volatility of capital markets as a whole (Manela, Moreira, 2017); the prevalence of news in the press on conflict states can increase the systemic risk associated with the financial system both nationally and internationally (Aninger *et al.*, 2018).

3. Social media is a new way of communicating information in modern societies and is a real alternative to traditional media. The use of social media, the Twitter information

communication system or internet searches are new channels through which information can be propagated in modern societies. Studies on how investors and capital markets react to social media are explorers, offering in few cases strong arguments about theoretical foundations. Thus, Bukovina (2016) considers that although there is a great deal of empirical evidence for this relationship, there are still numerous doubts concerning, in particular, the theoretical basis or methodological aspects used in this category of studies.

Despite the fact that both vehement critics and avid supporters of these categories of data sources have a great view of the literature, it is important to distinguish between the nature of the media sources available: social networks, Twitter or internet searches with the help of specialized search engines.

a) Studies on the influence *of social media* on the evolution of share prices attempt to quantify the discussions and the nature of the information present on social media sites in the form of an index that measures the degree of happiness (fulfilment) of participants, which they then use as a reference in the evolution of capital markets. Studies such as Karabulut (2013) or Siganos *et al.* (2014) note that the general perception extracted from social media members' posts (usually Facebook) is strongly correlated with the evolution and volatility of capital markets. However, some critics note that it is very difficult to measure this indicator because its quantification raises serious methodological problems (Hussein, 2016).

b) The *Twitter* platform is another important social media communication channel that can exert a strong influence on the future evolution of capital markets. Similar to social media, studies targeting the Twitter platform are building a series of indices that reveal investors' general perception of the economic climate based on posts on the platform. Studies such as Bolen *et al.,* (2011), Spenger *et al.,* (2013) or Spenger *et al.*, (2014) indicate a strong relationship between the nature of the information posted on the Twitter platform and the volume of transactions and the volatility of capital markets as a whole. In the case of these categories of studies, it is generally used between a "calm" dimension of the behaviour of members on the platform, which is then used as a reference in forecasting the evolution of the capital market.

c) With the generalization *of searches on Internet* as an easy way to document various social or economic aspects, some researchers use the number of searches of a company as an indicator, aimed at investor perception. In the case of this category, the empirical results reveal that the number of Google searches can be used to predict the evolution of a company's share price over the next two weeks, or the price of an initial public offering (Da *et al.,* 2011) even being able to quantify the long-term performance of a company (Uyeteph *et al.*, 2011) and even highlight the biggest issues of panic among investors (Da *et al.*, 2015). This category of data source is considered to be the most relevant in the construction of news-based volatility indices because it does not involve the use of concepts and techniques specific to sociology or psychology being used directly data made available by Internet search sites (Vozlyublennaia, 2014). In addition, some authors, such as Da *et al.*, (2015) explicitly encourage academia to make the most of this category of data, as they are set in the objective without the subjective intervention of the researcher.

Overall the data sources targeting online platforms highlight increased access for investors to as many sources of information as possible with technological advances over the past 20 years. However, the innovative and difficult to quantify character often induces

a high score on the results obtained, and their use should be carried out with caution by the researchers.

4. A direct consequence of technological developments in automatic data processing has enabled the incorporation **of all available data categories** with a view to building a news-based volatility index. With advances in the automatic processing of data using artificial intelligence algorithms, it has been possible to achieve volatility indices that incorporate all available data sources: company announcements, press information, social media and other categories of sources of information. In general, this broad category of data sources start first from information in the press on the economic and social situation of a state and then verify that the information is relevant to each company (Boudouk et *al.*, 2019). Within this category of indices, we are witnessing a step-by-step verification of each category of news circulated on official channels and then there is an integration of information on the company's climate into the construction of the volatility index.

The processing methods in this data source are revolutionary, which is why there are few studies using this technique such as (Aninger *et al.*, 2018) and (Boudouk *et al.*, 2019), but the empirical results reveal the effectiveness of these techniques being possible to test both the effects of the economic climate and those related to the intrinsic aspects of companies. Thus, (Boudoukh et al., 2019), notes that 49.6% of idiosyncratic volatility (company-specific volatility) is the result of news that appears in the press outside trading hours that subsequently affects the evolution of the prices of listed companies. By contrast, only 12.4% of idiosyncratic volatility corresponds to normal trading hours, which confirms the importance of accurately determining the relevance of the information conveyed in media channels.

Finally, the extensive typology of data sources that can be used in the development of news-based volatility indices reveals not only the nature of the information that is circulated in media channels but also the source through which it reaches investors. The empirical results reveal that there are both similarities and differences between the way an investor reacts to the direct information provided by a company, or the information circulated in the specialized press or social media. Therefore, modern trends in this direction reveal the need to include as many data sources as possible in the quantification and measurement of news-based volatility indices.

3. DEBATES SURROUNDING NEWS-BASED VOLATILITY INDICES

The concept of news-based volatility indices has recently emerged in the literature out of a desire for academia to better understand the way information is propagated in financial markets. The innovative nature of this subject has required both the validation or reconsideration of traditional approaches in economic theory and the raising of several dilemmas on the functioning mechanisms of capital markets. That is why we propose to treat two important directions separately in this direction: (1) the implications of volatility indices on information transmission mechanisms in capital markets and (2) dilemmas and controversies regarding news-based volatility indices.

3.1 Implications of volatility indices on information transmission mechanisms in capital markets

Modern theories on portfolio management (Markowitz, 1952) and the informational efficiency of financial markets (Fama, 1970) have placed great emphasis on the influence of news on how a financial market evolves. From a theoretical point of view, a capital market is effective if the share price fully reflects all the information available at any given time. In this context, news-based volatility indices can explain how a capital market is or is not informationally efficient, but in particular may indicate factors influencing the mechanism for transmitting information in the market. Some of the most relevant results in this direction are the following:

a) *investor pessimism* is an important factor in predicting the evolution of short-term and long-term capital markets. A whole series of studies use a determining factor in determining volatility indices is the perception that investors have of the future evolution of a company. Thus, if the general perception of the future evolution of the capital market is a pessimistic one then the share price is reduced and volatility increases (Tetlock, 2007). Empirically, the same general conclusions were obtained by using: dedicated headings in specialized journals (Tetlock, 2007), social networks (Bolen *et al.*, 2011), Internet search results (Da *et al.,* 2015) or processing information on the economic climate in a state (Manela, Moreira, 2017). Investor pessimism contributes to the short-term evolution of capital markets and the general perception of investors influences the evolution of capital markets;

b) *the social and macroeconomic climate* contributes to the long-term evolution of capital markets. Information on the evolution of macroeconomic indicators (Bitz, Lott Jr., 2011; Stotz, 2019), the instability of public policies (Gulen, Ion, 2015) or the presence of conflicts in a state or between states (Manela, Moreira, 2017) exert a strong influence on the volatility of capital markets. More often than not, macroeconomic demographic shocks are indirectly reflected on the evolution of capital markets as a whole;

c) *corporate governance information is the economic basis* for comparing the effects of news on a company's future development. In general, most studies using news-based volatility indices compare their effects with the effects of corporate governance news information at company level: publication of financial statements, changes in company management, mergers or acquisitions, etc. (Chan, 2003; Tetlock, 2007; Tetlock *et al.*, 2008; Liu and Zang,2015).

d) *in the short term the information causes prices to fall and in the long term to increase the trading volume* because investors sometimes react under the impetus of a general market condition while in the long term the fundamentals of the market come in (Tetlock, 2007).

Finally, news-based volatility hints highlight not only the importance of a company's economic fundamentals but also the role that information and investor perception plays in the evolution of capital markets.

3.2 Dilemmas and controversies over news-based volatility indices

The valuation of financial assets involves objectively quantifying the price of an asset by reference value, as it follows not only the present value but also the ability to predict how the prices of a financial asset are determined. In this context, we consider it

appropriate to present some dilemmas on these indicators, but also some controversial aspects concerning their evolution.

Regarding *the dilemmas* regarding the efficiency and ability of news-based volatility indices to include all the information needed to outline a general perspective, we list some of these:

a) *the economic climate and investor perception or economic foundation* are two categories of factors that are often used in volatility indices but few studies manage to distinguish precisely what is the determining factor in this relationship. Most often studies report only the economic foundation without a test of the importance of these (Tetlock, 2007), or avoid testing the phenomenon (Boudoukh *et al.*, 2019);

b) *the proximity effect dilemma* concerns how emerging capital markets react to information that occurs in developed capital markets. It is unclear whether the initial volatility and shocks are transmitted directly or whether there is a proximity effect (Baumöhl *et al.*, 2018). From a theoretical point of view, the proximity effect implies that a shock from a developed capital market spreads uniformly among groups of close states in the form of proximity. Thus, the shocks are not from one country to another but rather from one country to a group of states. Currently the literature unclear whether there is the proximity effect how it can be measured, or what are the determinants of this phenomenon.

c) *systemic risk transmission mechanisms and corporate governance* are unclear aspects in the literature with studies present, which reveal that with the increase in shareholder rights increased the risk system associated with them (Aninger *et al.*, 2018). This questions the extent to which it is important for national capital markets regulators to continue to increase shareholder rights if this increases the risk of the system as a whole. It is or is not beneficial to increase shareholder rights in with the danger of increasing the risk of the whole system.

In addition, there are some authors such as Bukovina (2016), Deb *et al.,* 2017) or (Yang, *et al.,* 2019) who reveal a whole series of *discrepancies* in the design of news-based volatility indices. In general, criticism of news-based volatility indices mainly concerns: methodological gaps in the quantification of the perception of Bukovina investors (2016), the low comparability of results between different data sources (Deb *et al.,* 2017), or even criticism scars on how to calculate some types of risk indices (Yang, *et al.*, 2019). Since most of the criticism of the indices is rather concerned with methodological difficulties, the topic is still prone to extensive analysis on the subject.

Finally, news-based volatility indices are a series of economic indicators that attempt to identify, test and predict the evolution of capital markets in relation to new information emerging in the market. Their innovative nature has provided the opportunity to confirm numerous economic theories, but also highlights both new dilemmas and controversies that arise in the literature.

4. CONCLUSIONS

The aim of this paper was to establish what are news implied volatility indexes, and how can they be used in order to quantify and predict investor's reaction to new information depicted in the media.

The impact of new information on stock prices has been a key focus for many scholars and policy makers ever since the development of modern portfolio theory and

advances in corporate and financial risk management. Therefore, trying to build and develop indexes that can allow the prediction of investors behaviour pose and intriguing aspect for scholars and policy makers. Despite the abundant types of data that can be used to build such indexes, our analysis indicates that while some data sources can be reliable and used as a baseline to predict future stock prices, most of them are either situational or have limited applicability. While information about the companies or using trusted news media data sources, internet searches or even all the available data sources can help predict future price in certain situation, their applicability seems to be limited in certain situation.

The development of a growing number of news-based volatility indexes, has revealed another set of limits of these types of data. First, we find that as more and more investors are acknowledging this source of data, we cannot answer what factor plays the major role in the efficiency of the index, as information about the company, news regarding the general economic and social environment, corporate governance indicators or types of data, all seem to contribute equally to the success of the index. Furthermore, there is a lot of controversy surrounding the efficiency of the data used in the analysis, as most of the indexes that rely on internet searches are highly controversial. Meanwhile, we find that these indexes pose additional question such as if the main issues are general investor perception or the normal macroeconomic environment, can we test the presence of the proximity or the systemic risk factor using these types of indexes.

Even if news-based volatility indexes can be used as proxies for depicting new information in news media, they can also be used as indicators of the general investor's perception on the economic environment. This will allow policy makers to ensure that each individual measure they take will take into consideration not only their economic influence but also their impact on the general investor perception.

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